From Screening to Success

Navigating the Vapor Intrusion Pathway at Brownfield Sites

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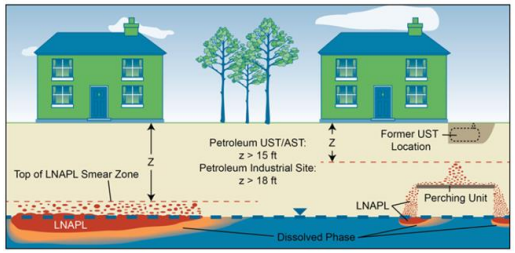


Figure 3-5. Vertical screening distances for LNAPL source.

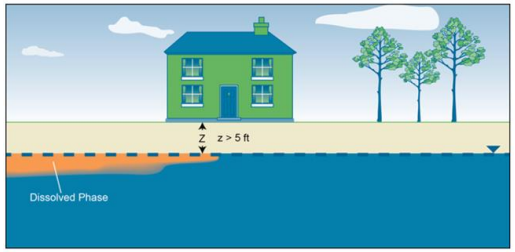
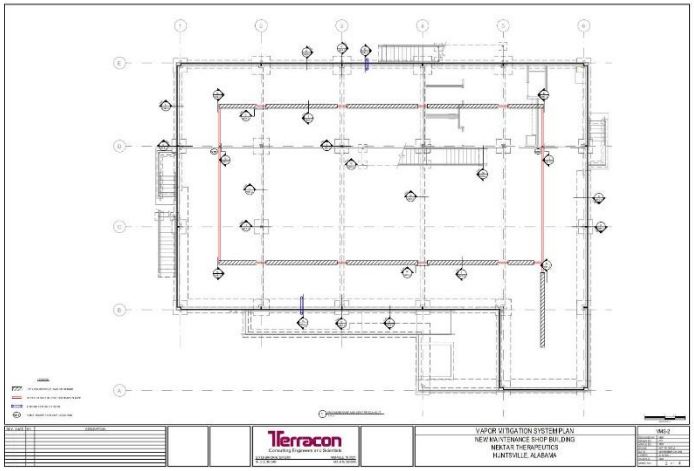


Figure 3-6. Vertical screening distances for dissolved-phase source.



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Vapor and Due Diligence

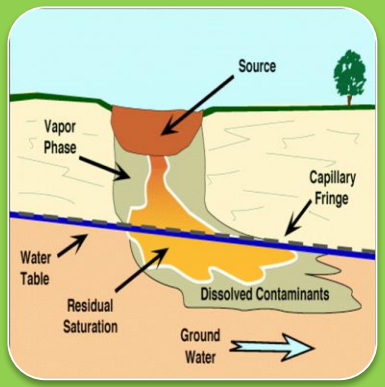
ASTM E1527-13 (Phase I ESA)

- References vapor specifically (the -05 standard did not).
- "3.2.56 migrate/migration – for the purposes of this practice, migrate and migration refers to the movement of hazardous substances or petroleum products in any form, including, for example, solid and liquid at the surface or subsurface, and **vapor** in the subsurface."

ASTM E2600-15 (Vapor Encroachment Screening)

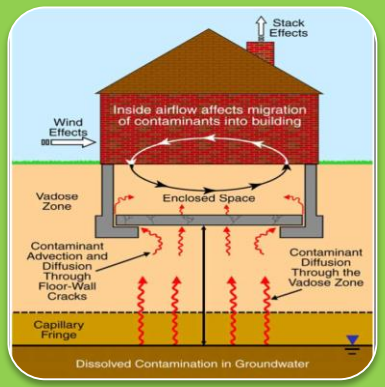
- Tier I and Tier II screening processes.
- "X1.6 …vapor encroachment is the **potential** for migration of vapor contaminants onto (or through the subsurface of) the target property. Vapor encroachment is a separate and distinct concept from vapor intrusion. Vapor intrusion evaluates potential exposure risks to persons with a building resulting from vapor migration into structures."

Encroachment vs. Intrusion



Vapor Encroachment (VE)

- Migration of contaminant vapors from soil, groundwater, or preferential conduit onto the subject property.



Vapor Intrusion (VI)

- Migration of contaminant vapors from soil, groundwater, or preferential conduit into a building.

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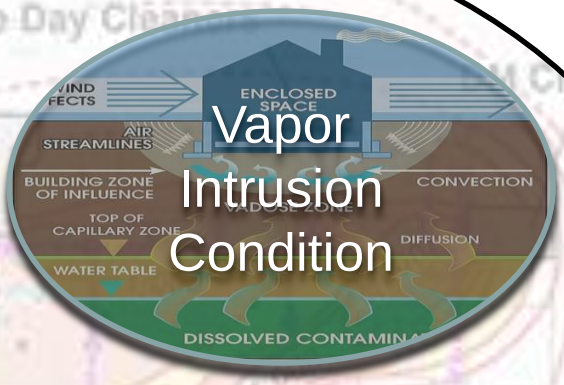


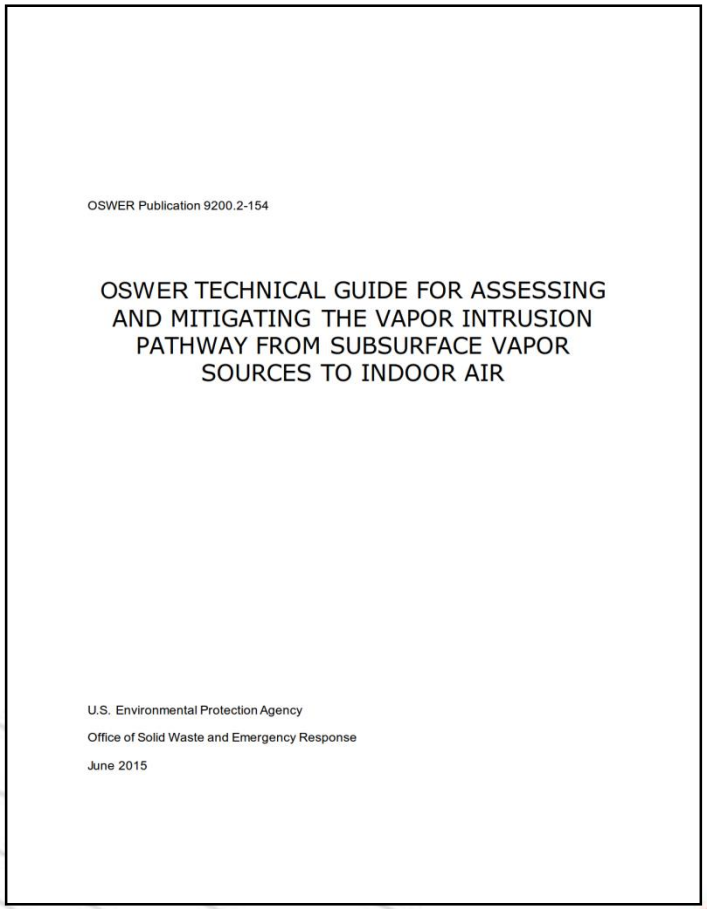
Vapor Intrusion Condition

Vapor Encroachment Condition

EPA June 2015 OSWER Guidance

- Focused on VI pathway in general and geared toward evaluation of non-petroleum hydrocarbon VOCs

- Replaces draft 2002 guidance (essentially a new document)



OSWER Publication 9200.2-154

OSWER TECHNICAL GUIDE FOR ASSESSING AND MITIGATING THE VAPOR INTRUSION PATHWAY FROM SUBSURFACE VAPOR SOURCES TO INDOOR AIR

U.S. Environmental Protection Agency

Office of Solid Waste and Emergency Response

June 2015

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Primary Takeaways on EPA OSWER Guidance

- Emphasis on
  - Site characterization (Conceptual Site Model)
  - Multiple lines of evidence
  - Site data – not sole reliance on models
- Default attenuation factor (α) for soil gas to indoor air modified from 0.1 to 0.03.
- Sub-slab sampling preferred if buildings present.
- “Near-source” sampling depth recommended for exterior soil gas or if no buildings present.
- Recommendation to use EPA VISLs/RSLs over occupational criteria (i.e., PELs or TLVs) in non-residential settings.

OSHA® vs. EPA United States Environmental Protection Agency

Section 7.4.3 Occupational Exposure Limits

"Permissible exposure limits (PELs)…were intended to protect workers against catastrophic effects (such as cardiovascular, liver, kidney, and lung damage), as well as more subtle effects (such as narcosis, central liver system damage, and sensory irritation). PELs (and TLVs), however, are not intended to protect sensitive workers, may not incorporate the most recent toxicological data, and may differ from EPA derivations of toxicity values with respect to weight-of-evidence considerations and use of uncertainty factors. **For these and other reasons, EPA does not recommend using OSHA's PELs (or TLVs) for purposes of assessing human health risk posed to workers by the vapor intrusion pathway or supporting final "no-further-action" determinations for vapor intrusion arising in nonresidential buildings."**

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OSHA® vs. EPA United States Environmental Protection Agency

Why is this important?

- Screening process may eventually lead to an indoor air quality (IAQ) study.

- Industrial hygienists often do not utilize EPA RSLs when evaluating results of an IAQ study.
- If vapor intrusion is a suspected pathway at the site and can not be ruled out by other methods, then IAQ results should be compared to EPA RSLs for industrial air.
- Indoor air quality studies are often recommended as a last resort when evaluating VI due to difficulty in distinguishing the source of the contamination.

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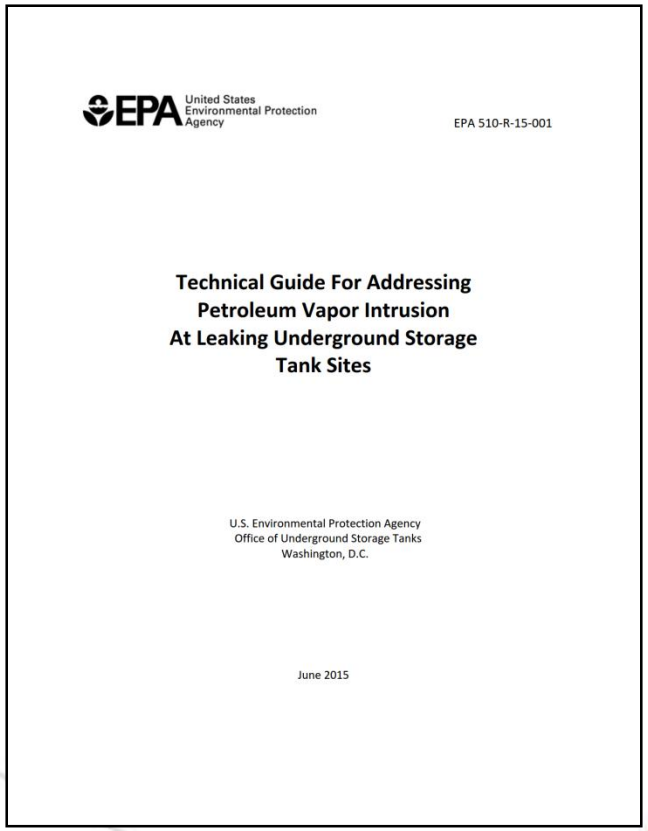
EPA OUST Guidance

- Alternative screening approach for petroleum UST sites.
- Based on research indicating reduced Petroleum Vapor Intrusion (PVI) risk due to bioattenuation of petroleum hydrocarbons in soil gas.
- More prescriptive than OSWER document.
- Generally similar to ITRC PVI Guidance (October 2014).



EPA United States Environmental Protection Agency

EPA 510-R-15-001

Technical Guide For Addressing Petroleum Vapor Intrusion At Leaking Underground Storage Tank Sites

U.S. Environmental Protection Agency
Office of Underground Storage Tanks
Washington, D.C.

June 2015

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Petroleum VI vs. Chlorinated VI

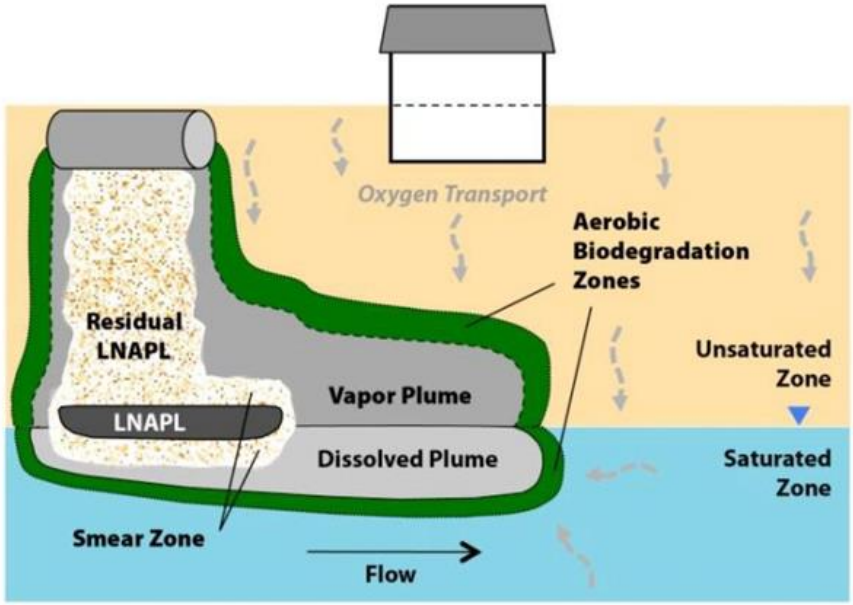

Figure 1. Typical petroleum hydrocarbon transport conceptual scenario

Aerobic biodegradation of PHCs along the perimeter of the vapor and dissolved plumes limits subsurface contaminant spreading. Effective oxygen transport (dashed arrows) maintains aerobic conditions in the biodegradation zone. Petroleum LNAPL (light nonaqueous phase liquid) collects at the groundwater surface (the water table, blue triangle).

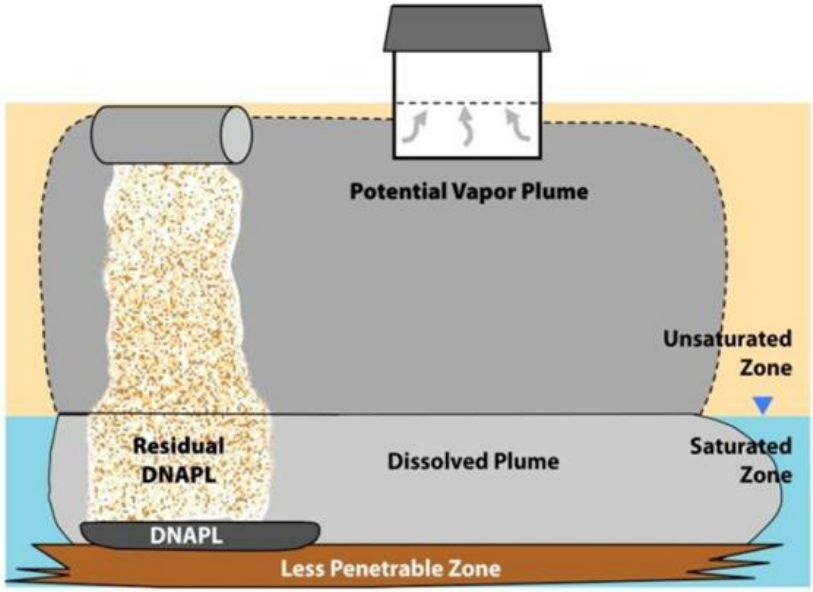

Figure 2. Typical chlorinated solvent transport conceptual scenario

Biodegradation of CHCs is anaerobic and usually slower than PHC biodegradation, so that the vapor and dissolved plumes often migrate farther than PHC plumes. CHC DNAPL (dense nonaqueous-phase liquid), if present, can sink below the water table, collecting in this case on a less penetrable layer.

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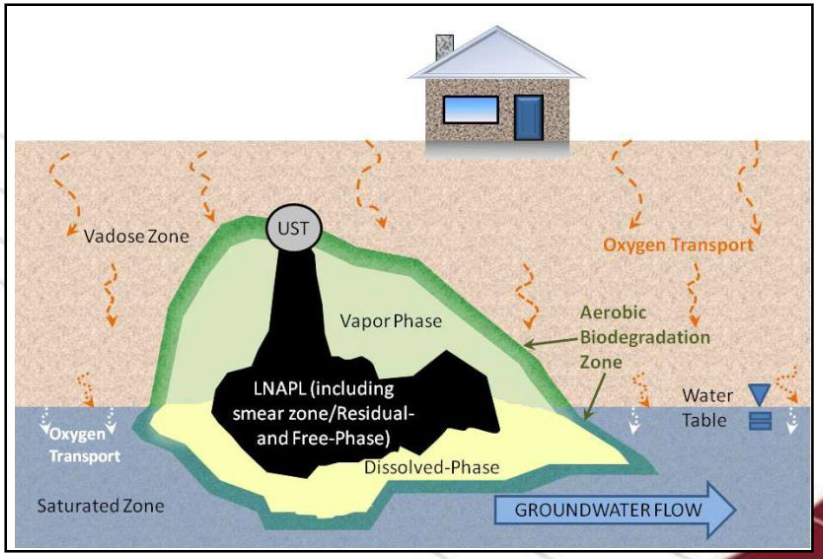
EPA OUST Guidance – Primary Takeaways

- Introduction of Vertical Separation Distances
- Emphasis on
  - Site characterization (Conceptual Site Model)
  - Precluding factors
  - Lateral inclusion



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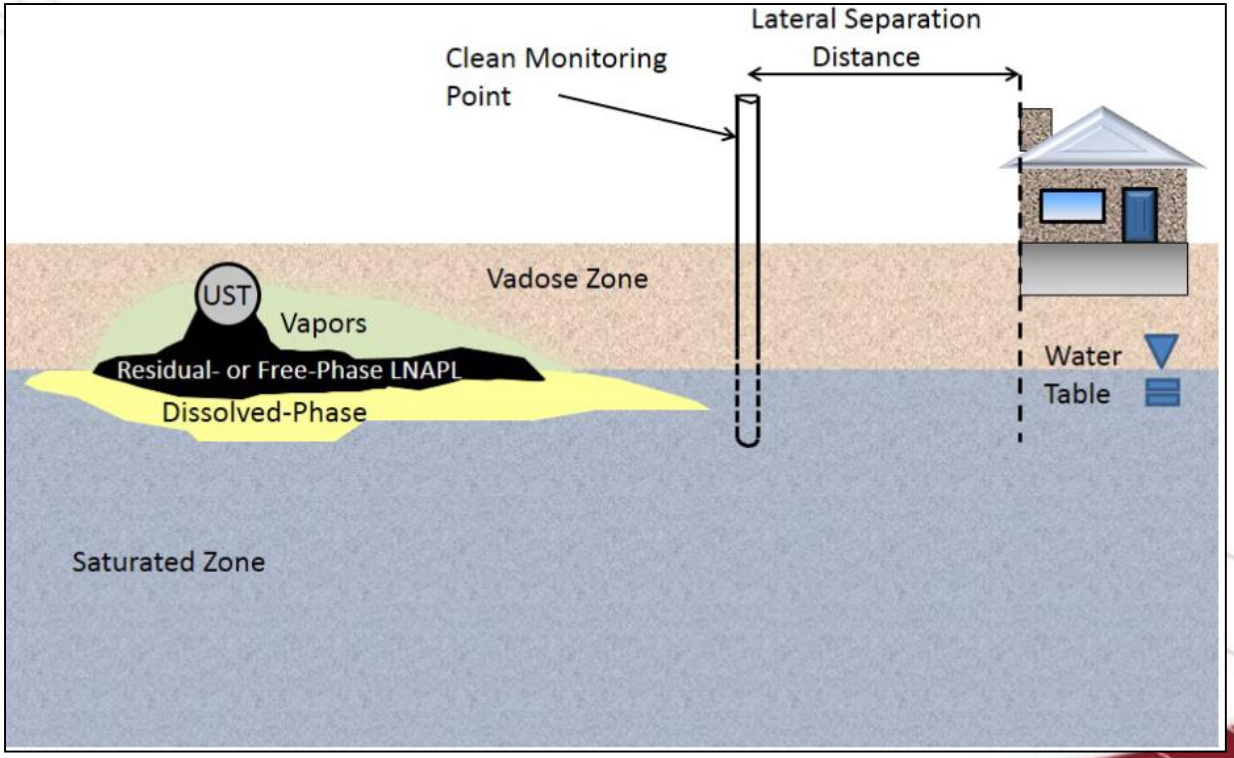
EPA OUST Guidance

- Lateral inclusion
  - Lateral separation distance considered site-specific (no reference to 30-ft default mentioned in ITRC PVI Guidance)



EPA OUST Guidance

- Vertical Separation Distances

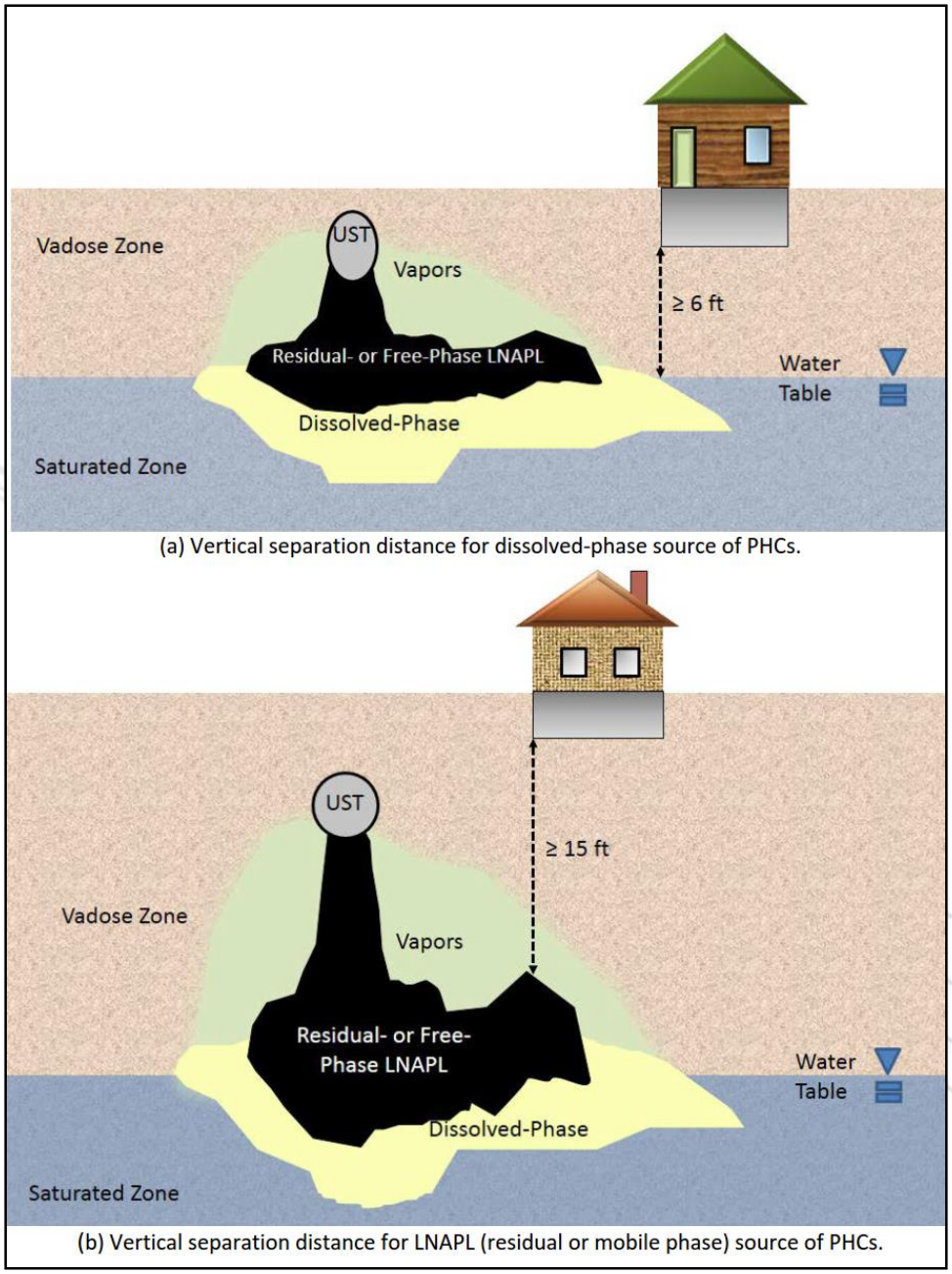
Table 3. Recommended Vertical Separation Distance Between Contamination And Building Basement Floor, Foundation, Or Crawlspace Surface.

Media	Benzene	TPH	Vertical Separation Distance (feet)*
Soil (mg/Kg)	≤10	≤ 100 (unweathered gasoline), or ≤ 250 (weathered gasoline, diesel)	6
	>10 (LNAPL)	> 100 (unweathered gasoline) >250 (weathered gasoline, diesel)	15
Groundwater (mg/L)	≤5	≤30	6
	>5 (LNAPL)	>30 (LNAPL)	15

*The vertical separation distance represents the thickness of clean, biologically active soil between the source of PHC vapors (LNAPL, residual LNAPL, or dissolved PHCs) and the lowest (deepest) point of a receptor (building basement floor, foundation, or crawlspace surface).

EPA OUST Guidance

- Vertical Separation Distances



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EPA OUST Guidance

- "Clean, Biologically-Active Soil" defined in Section 9 of guidance
- EPA's Recommendation

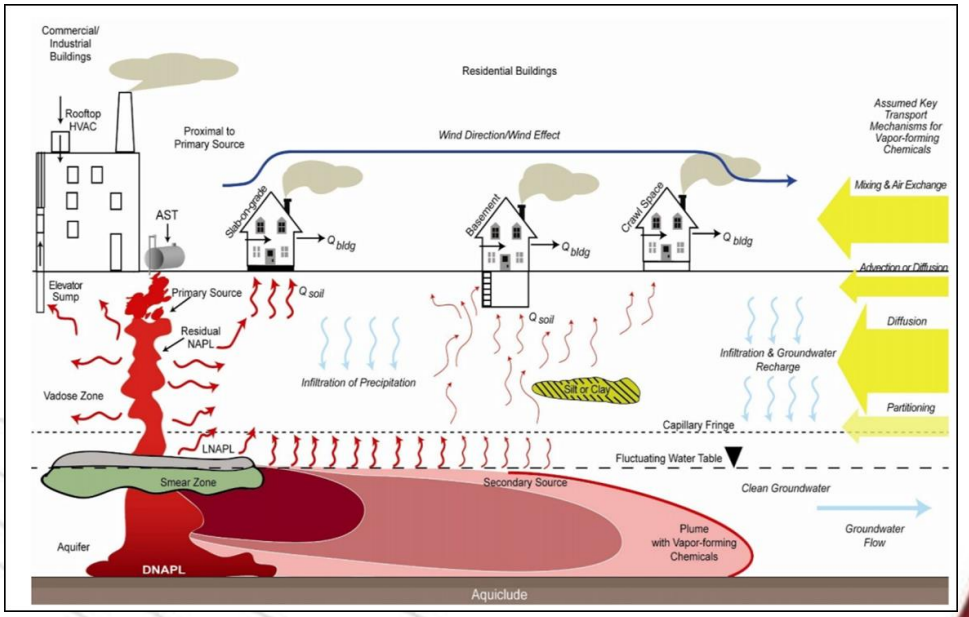
Recommendation

Based on EPA (2013a), clean, biologically active soil does not contain LNAPL, EPA recommends LNAPL thresholds of 100 mg/Kg TPH (fresh gasoline) and 250 mg/Kg TPH (weathered gasoline and diesel). Except for the geological materials identified in *Special Considerations*, most soils contain indigenous microorganisms, sufficient oxygen, and adequate soil moisture necessary for degrading PHC vapors. Thus, it is typically not necessary to run microcosm studies or plate counts to test for microbial presence. However, if the conditions at the site are uncertain for supporting aerobic biodegradation, EPA recommends that appropriate samples be collected and analyzed to verify conditions at the site.

Conceptual Site Model

Understanding a Complex Pathway

- Preferential pathways
- Environmental effects
  - Soil moisture
  - Barometric pressure
  - Temperature
  - Contaminant migration
- Building effects
  - HVAC variations
  - Advection
- Seasonal variability
- Get empirical data!



Investigation Considerations

- Sampling Depths
  - Sub-slab recommended if subject building is present.
  - “Near-source” depths for exterior soil gas or if buildings not present.
  - Consider bioattenuation for PVI – possible bias toward shallower sample depths (usually no less than 3 ft-bgs).
  - Mixed petroleum and chlorinated sources – consider nested probes with different depths

Sampling Depth and Influence of Building on Vapor Distribution (Non-Petroleum Compounds):

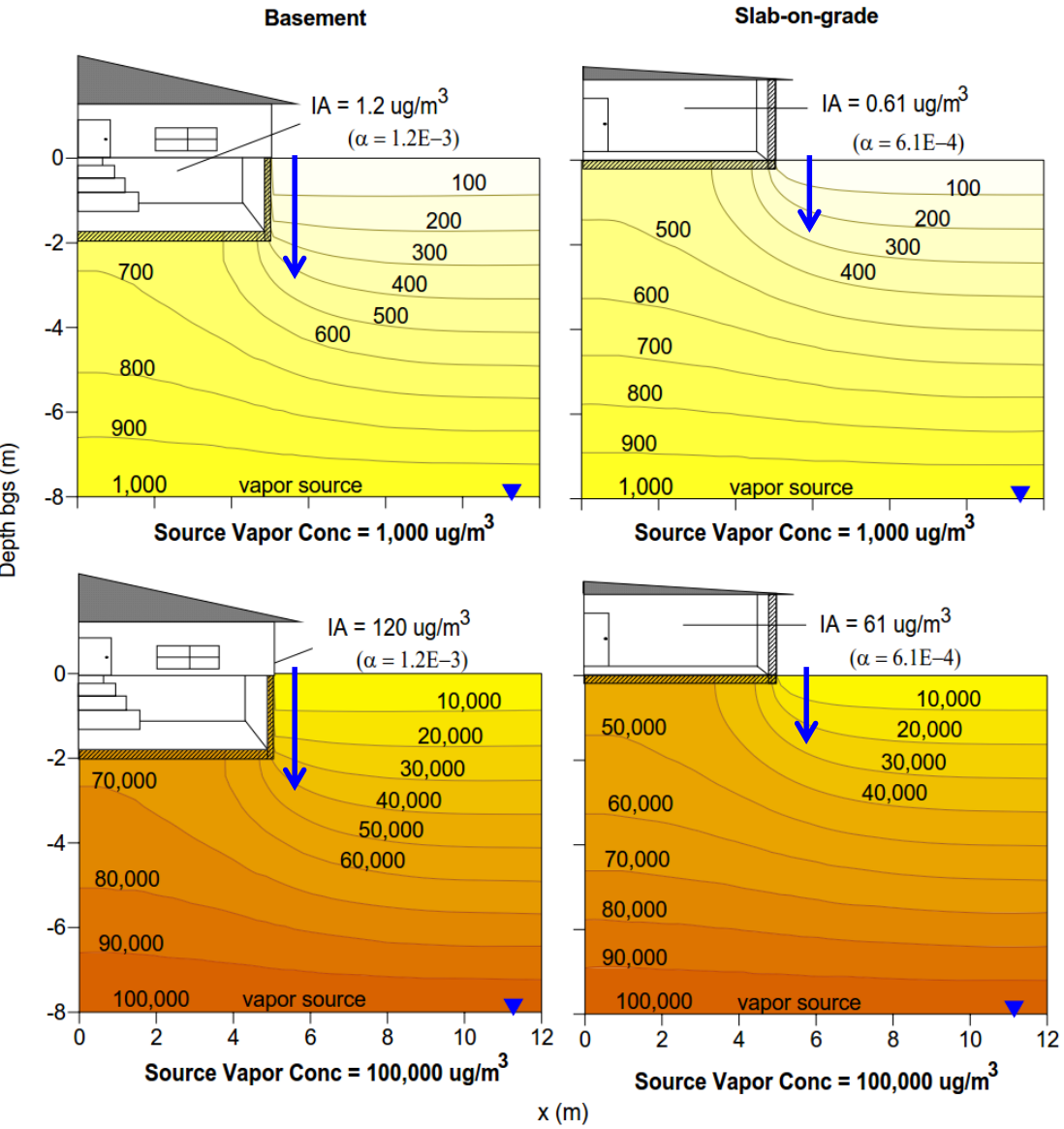


Figure 7a. Effect of source vapor concentration and foundation type on soil vapor distribution and indoor air concentration.

Soil vapor concentration contour lines are in units of μg/m³. IA is the indoor air concentration in units of μg/m³ and α is the normalized indoor air concentration (dimensionless). The source is located at 8 m bgs.

- Part of rationale for sub-slab or near-source
- Possibility of over-estimating risk with near source
- Judgement call based on available info

Source: EPA 2012, Conceptual Model Scenarios for the Vapor Intrusion Pathway

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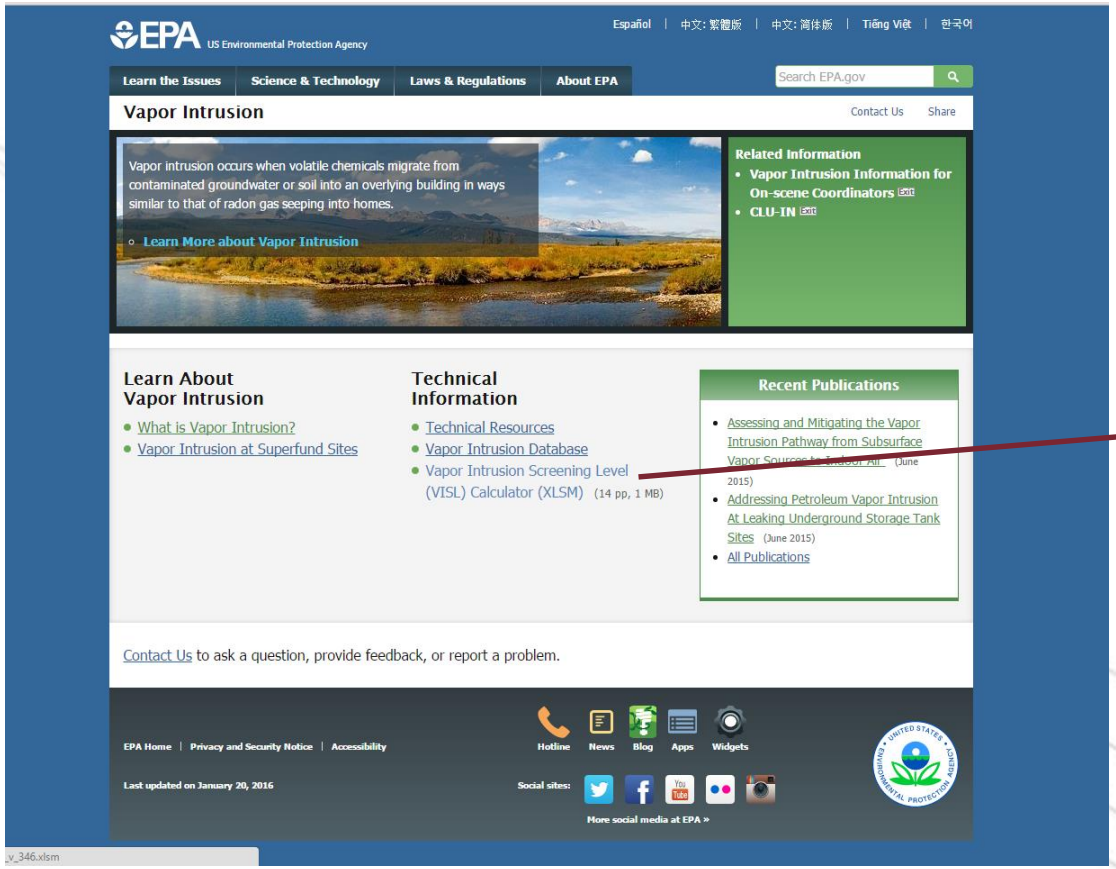
Use the VISL? Fo shizzle!



VISL Calculator link

https://www.epa.gov/vaporintrusion

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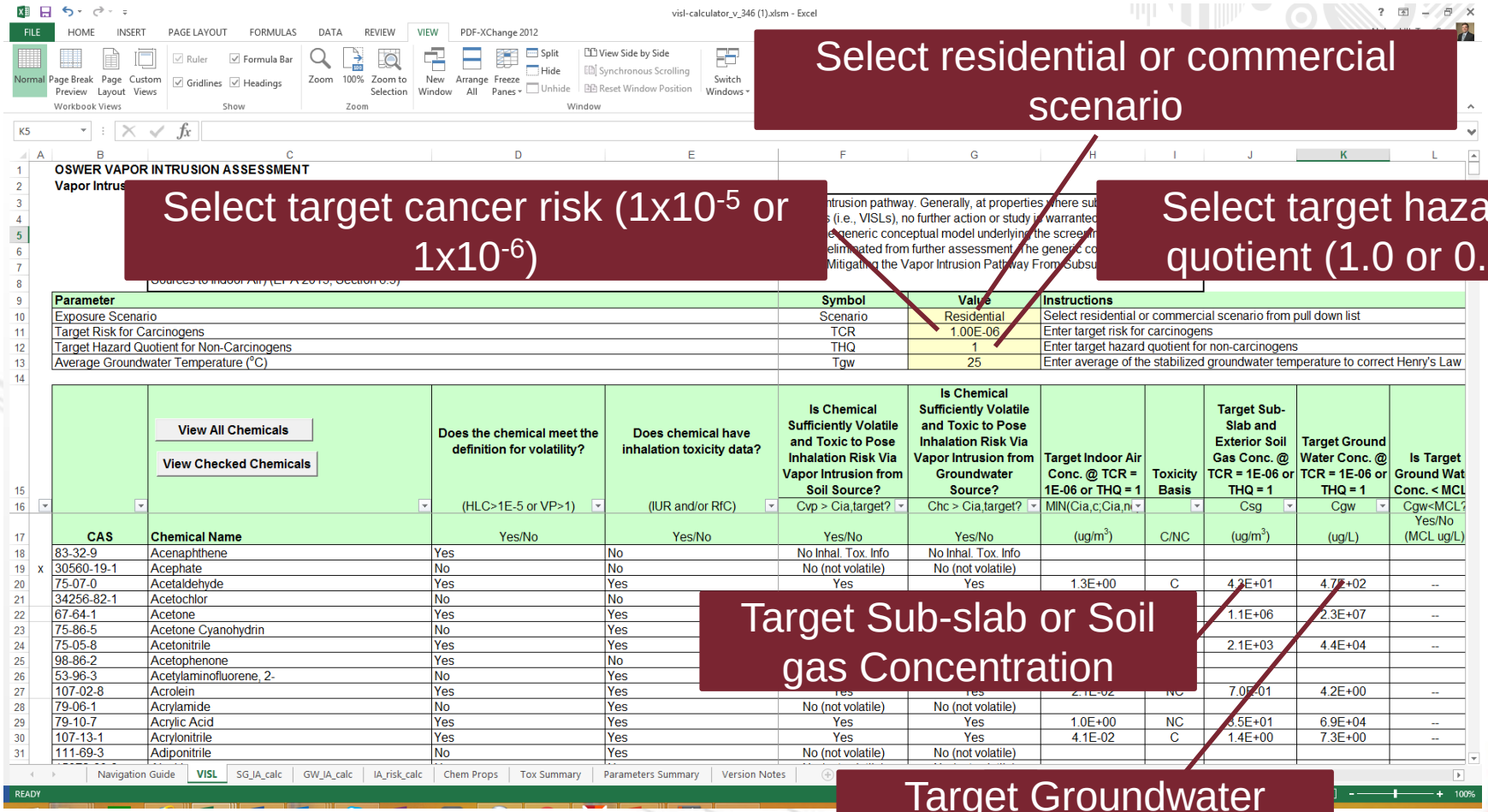

Target sub-slab or soil gas concentration is just the EPA RSL with the applied attenuation factor of 0.03.

Vapor Intrusion Mitigation

- When to mitigate?
- “Visqueen & Duct Tape – The DIY Approach to VI Mitigation”

Vapor Intrusion Mitigation

- When should you mitigate?
  - When data indicates unacceptable vapor intrusion risk
    - Screening level or risk-based concentration exceedences
  - If there is uncertainty and preemptive mitigation is more cost- and schedule-effective than intensive investigation

Common Mitigation Options

- New Construction
  - Spray-applied vapor membrane (e.g. Geoseal®, Liquid Boot®)
    - Recommended for moderate to high risk sites and chlorinated solvent sites
    - Certified installation
  - Sheet membrane (e.g. Vapor Block 20 Plus®)
    - Often reserved for use on low-risk petroleum hydrocarbon sites
    - Ensure product has testing to support resistance to VOCs (most membrane barriers do not)
    - Difficult to ensure that proper sealing of seams and utility penetrations is conducted (no certified installation available)
  - Passive or Active Venting
    - Typically utilized in conjunction with barriers
    - Active generally reserved for higher-risk sites

Common Mitigation Options

- Existing Buildings
  - Sub-slab depressurization (SSD)
    - Similar to typical radon systems
    - Most-common approach for existing structures
    - Involves pilot testing and pre-installation diagnostics
    - Involves long-term O&M costs
  - Retro-Coat ®
  - Spray-applied membrane with new slab
  - Sealing of cracks/penetrations
    - Effective but generally not accepted as sole method of mitigation for existing structures
  - Positive building pressurization
    - Effective but generally not accepted as sole method of mitigation for existing structures

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